ALLIANCE FOR THE CHESAPEAKE BAY
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Underwater grasses at the tipping point?

Despite gains at Susquehanna Flats, most of the Bay's eelgrass is feeling the heat from climate change, water clarity

By Karl Blankenship

If someone had placed a bull's-eye on a map identifying the hot spot for waterfowl a century ago, it would have been the Chesapeake Bay, where ducks and geese gathered each winter in "numbers beyond credence or computation," according to one naturalist. What attracted them were vast beds of underwater grasses so dense, another ornithologist reported, that "a boat with difficulty could be rowed through it, it so impedes the oars."

The hot spot within the Chesapeake was the Susquehanna Flats, a shallow track near the mouth of the Bay's largest tributary where, according to a newspaper account from the mid-1800s, grasses grew in water "eight to nine feet in depth" in areas "which are never wholly bare."

But a century of pollution left those grasses in decline by the 1950s and 1960s, and in 1972, Hurricane Agnes smothered what was left under a layer of sediment.

For more than two decades, the once-lush habitat was a barren landscape, with only a few, scattered plants. Many thought the grasses were gone forever. But in a comeback that astonishes many scientists, the flats today boasts the largest, densest grass bed in the Chesapeake, covering more than 5 square miles.

"Having spoken to people who have spent the last 30 years fishing and hunting around the flats, it has never been that good," said Mike Naylor, a biologist with the Maryland Department of Natural Resources.

The Susquehanna Flats is not alone. In the past two decades, underwater grass acreage in low-salinity areas of the Bay and many of its tidal tributaries have bounded back from historic lows to numbers unseen in more than a generation.

Unfortunately, the same story isn't true for much of the Chesapeake. In high-salinity water 100 miles south of the flats, Bob Orth sees far less vegetation this year than when he began studying submerged aquatic vegetation—or SAV—more than three decades ago. Grass acreage in those areas had already trended down for more than a decade before a hot spell last year triggered a widespread die-off of eelgrass, the primary species in high-salinity areas.

"I go to places where I've been working for 30 years and see dramatic changes," said the Virginia Institute of Marine Science researcher. "It is amazing how many places have so little eelgrass this year."

SAV is a critical habitat for waterfowl, fish and shellfish. It's also considered to be one of the best indicators of overall Bay health. The grasses' survival is closely linked to clear water: If too much sediment or nutrient-fueled algae blooms cloud the water and block needed sunlight, the SAV dies.

SAV are so important, in fact, that improving growing conditions for them was one of the top goals of new water quality standards established last year for the Bay and its tidal tributaries by federal and state agencies. Those standards are driving a multibillion-dollar effort to control nutrient and sediment pollution throughout the Bay's 64,000-square-mile watershed. If met, the standards are aimed at reviving 185,000 acres of grasses in the Chesapeake—up from 78,000 last year.

But if grasses are an indicator of the Chesapeake's health, their message is nearly as cloudy as much of the Bay's water.

Scientists say that's because the Bay is an ecosystem "on the edge" when it comes to grasses. When the beds pass a certain "tipping point" in improved water quality, long-lost beds can rapidly spring back. On the other hand, they can just as easily tip in the wrong direction.

Clear water and adequate sunlight are the most important factors influencing the survival of plants, but stressed beds can easily fall victim to an array of other woes from nearby development, cownose rays—even global warming. In some cases, even the biology of the plants can work against them. "We're trying to manage a system on the edge," said said Ken Moore, a seagrass scientist at VIMS. "It doesn't take much to put you over the edge."

While conditions have tipped in favor of the grasses in low-salinity areas, many scientists worry that conditions are working against the grasses in medium and high-salinity regions. The Bay recovery may hinge on how those areas tip: Seven-eighths of potential Baywide SAV habitat are in medium– and high-salinity areas. If the grasses do not come back there, the Bay Program goal may never be attained.

Despite all of the attention today, underwater grasses in the Bay—as well as most places around the globe—were a largely unnoticed ecosystem until recently. As a result, no one knows exactly what grass beds looked like in the past, or how various grass species were distributed around the Chesapeake. "That's the classic pattern," noted Peter Bergstrom. a fisheries biologist with the National Oceanic and Atmospheric Administration's Chesapeake Bay Office. "You don't really study something until you're worried about it."

Nonetheless, grasses certainly had periods of ups and downs in the past. In fact, scientists believe their high point was not when Capt. John Smith explored a "pristine" estuary. Rather, studies of sediment cores by Grace Brush and William Hilgartner of Johns Hopkins University suggest that grass coverage may have peaked in the 1700s, after land clearing for farms increased the flow of nutrients into the Bay, spurring additional plant growth.

That flow grew into a flood over time, though. Water quality worsened and the grasses began dying off. A Bay Program-sponsored review of historical aerial photos of the Chesapeake shows that grasses grew on at least 220,000 acres at various times of the past century. They also indicate a steady decline, generally starting in low-salinity areas, and then moving downstream.

In some low-salinity areas, the situation was worsened by an invasion of Eurasion watermilfoil, which displaced native plants in the 1950s—then disappeared. The final blow, almost literally, came from Hurricane Agnes in June 1972. Already stressed beds were washed away or buried under inches of sediment, as was the Susquehanna Flats.

It was a sign, scientists say, of just how quickly a stressed system can tip over the edge. "In a month or two, you can do a major knock-back that takes years or decades to recover from," said Bill Dennison, a vice-president of the University of Maryland Center for Environmental Science, who has researched underwater grasses in the Bay and Australia "We saw that with Agnes." A Baywide survey of underwater grasses in 1984 found just 38,226 acres.

It's not a pattern unique to the Chesapeake. Many scientists consider underwater grasses to be facing a global crisis, with sharp populations drops being reported worldwide. Grasses in the Caribbean are declining at a rate which will make them extinct within a matter of decades. A few years back, 600 square miles of grass beds disappeared in Australia within a matter of months.

In that context, the comeback in the low-salinity areas of the Bay is a bright spot globally. It shows that when efforts are made to clean up the water, grasses can respond—and quickly.

"We have seen measurable declines in nutrients coming across the fall line of the major tributaries of the Chesapeake Bay," Dennison said. "We've seen this great resurgence in response to that nutrient decline."

Water quality began improving in the upper tidal Potomac near Washington in the late 1980s after upgrades at wastewater treatment plants. Grass coverage went from nothing to more than 1,000 acres over the next several years. But scientists caution that water quality was not the only thing that tipped in favor of the grasses. An exotic plant, hydrilla, moved in and helped to create conditions for native plants to return.

That pattern was repeated in the upper tidal Patuxent in the early 1990s, when grasses went from nothing to 100 acres after upstream treatment plants reduced nutrient discharges. Several other western shore and upper Bay tributaries followed the same pattern in the late 1990s.

The crowning jewel for the comeback was the Susquehanna Flats. The former waterfowl haven was so devastated after Agnes that few expected it to recover. Although plants remained on the flanks of the flats, they could not reclaim their historic area. But starting in the late 1990s, reduced nutrient flows down the Susquehanna—probably aided by several years of drought that reduced sediment and nutrient flows into the area—transformed the barren flats into a grass bed so large that is no longer on the edge: It can control its own environment.

When a deluge of sediment-laden water filled the upper Bay after floods in late June, the grass beds on the flats showed up in aerial photos like the hole in a doughnut. The bed had become so big, and so dense, that it intercepted incoming sediment before it could cover the entire bed.

The Susquehanna Flats today operates almost like an organic machine. It is not only helps to manufacture its own habitat, but it churns out millions of seeds each year to produce new plants and expand the size of the grass bed. Thus, even in years like this, when turbid conditions knocked back grasses in deeper areas along the fringes, scientists expect it to rapidly bounce back.

“They should recover quickly in a year or two,” Naylor said. “Even if we had two or three bad years in a row, we would expect a rapid recovery now that we have that built-in tolerance through seeds.” It’s the type of resilience that scientists would like to see in other grass beds, but many of those that remain today are too small.

Yet that success story has not moved beyond the low-salinity areas of the Bay and its tidal tributaries. Scientists cite a number of reasons for the lack of improvement.

Part of the story is about light. Or the lack of it.

Water quality monitoring shows that while conditions have improved in many freshwater areas, those improvements have often not resulted in clear water farther downstream. In addition, sediment from wave action and shoreline erosion is a particular problem in many parts of the mid and lower Bay.

Sediment erodes from shorelines and clouds the water before it settles, and is stirred up again by waves, creating water too turbid for plants to get light. “There is a lot of evidence that in some parts of the Bay right now, further reductions in nutrients will not improve SAV,” Naylor said. “The reductions that are needed are changes in sediment.”

According to Bay Program computer model estimates, meeting nutrient reduction goals alone would only clear the water enough for 125,000 acres of underwater grasses. The rest of the SAV goal requires sediment control. But the wrong controls can be just as bad for grasses. Bulkheads and rip-rap reflect wave energy back into the water, stressing grasses.

Part of the story is also a matter of plant biology.

The freshwater plants that inhabit low-salinity areas require less light than the species that live in higher salinities. Freshwater plants evolved in lakes and ponds and are more adapted to problems of eutrophication, such as increased nutrients and sediment runoff. In addition, many freshwater species are “canopy formers” which mean the plants grow until they reach the surface, where they spread out and form sunlight-absorbing canopies, reducing the need for light to penetrate murky water.

Other biological factors may play a role, too. All underwater species produce seed and are capable of dispersing them for long distances. Waterfowl may play a more important role with freshwater species than high-salinity eelgrass, whose seeds germinate before wintering waterfowl arrive in the Bay. In addition, many freshwater species can disperse from fragments that break off and float from established beds, while it may be a much rarer occurrance for eelgrass.

One of the biggest impediments to recovery in high salinity water may simply be the lack of species diversity. Globally, far fewer species of underwater grasses have adapted to live in saltwater (about 60) than in freshwater (more than 400).

Most of the roughly 20 species of SAV found in the Bay are freshwater plants, and many beds found in low-salinity areas—such as Susquehanna Flats—consist of multiple species. Diversity often brings stability: If one species falters, another species is present to take its place.

Only two major species survive in medium– and high-salinity water: widgeon grass and eelgrass. When conditions turn bad and sends a grass bed over the edge there is often nothing to take its place—not even an exotic like hydrilla—in those areas.

The result is often seen dramatically in the midsection of the Bay. Once, it was the domain of both widgeon grass and eelgrass. As recently as the 1960s, eelgrass was common as far north as the lower Patuxent and Kent Island. Since Agnes, though, the northernmost extent of eelgrass has been the Honga River on the Eastern Shore, and Reedville, VA, on the Western Shore—a retreat of nearly 20 miles.

That has left widgeon grass as the main species in the Bay's midsection, which contains most of the Chesapeake's potential SAV habitat.

But widgeon grass is notorious for its year-to-year fluctuations in coverage. It is a prolific seed producer, and when water quality conditions are good, huge beds of widgeon grass beds spring forth. In years when conditions are poor, it disappears just as quickly. Today, much of the year-to-year variation in the Bay's SAV is driven simply by changes in widgeon grass abundance.

"There's more of it than there ever was," Dennison said. "It is well-adapted to environmental fluctuations. It has prodigious seed production." In a system on the edge, Dennison sees widgeon grass playing a bigger role in the Bay — he calls it the "grass of the future."

Meanwhile, scientists are crossing their fingers that eelgrass—the Bay's dominant high-salinity species which also had the largest habitat range just four decades ago—does not become a grass of the past. Not only has its recovery stalled, but last year raised a new concern about its future in the Bay: heat.

Eelgrass is near the southernmost extent of its range, which stretches from North Carolina to Greenland along the Atlantic Coast. Normally, eelgrass responds to the heat by shedding much of its foliage during the summer months, creating huge mats of floating vegetation, known as wrack. In fall, the plants return to life.

Last year, warm temperatures coupled with still water in many areas combined to cook the grasses. Most of the eelgrass in the Bay died. Those growing in most areas this year are from seeds produced before the die-off—fortunately, the eelgrass had produced a bumper crop before dying. But those plants won't produce seeds of their own until next spring; if something happens to them this year, there will be nothing left to produce a new crop of seeds in many areas. "Then it's gone," Orth said. "That's what's scary."

Surveys through late summer have raised hopes that most beds will make it until next year, although coverage remains sparse. "We may have dodged a bullet," Orth said.

It's a bullet that eelgrass may have to dodge more often. The five warmest years in the last century, in order, were 2005, 1998, 2002, 2003 and 2004. If that translates into a warming trend for Bay water, scientists say that it would be bad news for eelgrass.

The roots of underwater grasses, like wetland plants, live in sediments that have been drained of oxygen by bacteria. To survive, they have developed mechanisms to pump oxygen into the soil through their roots, a job that takes a huge amount of energy.

Summer heat speeds up the activity of bacteria in the sediment, which consumes oxygen. The plant has to counteract that by pumping even more oxygen through its roots into the sediment.

For eelgrass, which has adapted to surviving during the cold winter months—it's the only underwater grass that commonly overwinters in the Bay—the job is particularly tough. It does not photosynthesize fast enough to keep up with the increased oxygen demand encountered during extreme heat events. Instead, it has to draw down its stored energy reserves.

Sustained water temperatures above 85 degrees are lethal to eelgrass. But the heat is stressing the plants even before temperatures hit that mark because of the gradually increasing oxygen demand in the soil. That could be counteracted, to some extent, if the water was clearer, allowing the grass could get more sunlight and photosynthesize more effectively, saving some energy.

That typically doesn't happen in the Bay, though, as extreme heat is also conducive to the growth of algae in the water and tiny plants, known as epiphytes, directly on the leaves of underwater grasses. "We've got a double whammy," Moore said. "It's got to fight temperature, therefore it needs to photosynthesize more, yet it is getting less light—or at least no increase in light."

A warmer climate would have indirect impacts on the plants as well. Hot temperatures mean more energy in the atmosphere. That leads to more severe thunderstorms which drive more sediment and nutrients into the water than slower, soaking rainfalls. A warmer climate could also produce more, and stronger hurricanes that could rip up and erode beds along shoreline, as happened during Hurricane Isabel in September 2003.

If that weren't enough, recent research also suggests that eelgrass is affected not just by low-oxygen levels in the sediment, but also in the water—something that has become more common in shallow areas of the Chesapeake in recent decades.

Scientists don't believe it will be lost altogether, but those stresses could tip the odds further against eelgrass maintaining its current coverage—much less regaining areas lost over the past two decades. "It doesn't look good for eelgrass," Dennison said. "We are not going to see a massive recovery like we've seen in the lower salinity regions."

Scientists have tried to offer eelgrass a helping hand by transplanting it in potentially suitable habitats. In recent years, they have even ramped up efforts by using mechanical harvesters to reap millions of seeds from existing beds so that dozens of acres can be planted at a time.

Often, though, the efforts show how much easier it is to lose a bed than get one back. Maryland DNR biologists have been planting eelgrass in part of the lower Potomac and lower Patuxent for the past three years. This spring, the beds looked fine; then they were devastated by a pack of cownose rays, which dug them up in search of clams.

"It is so frustrating," Naylor said. "You get these plants that are doing really well and look like they are going to make it through the summer, and then the rays come in. It's a back-breaker."

SAV restoration efforts, in general, have had a poor track record in the Bay. More than 90 percent of the projects fail within three years. In part, that's because even large restoration projects—like those on the Potomac and Patuxent—are too small to control their own environment.

"When you have these seedlings starting out, they are small and they are weak and they are widely spaced. They rays can get right in them and dig them right up," Naylor said. "So we have to reach that critical threshold with our restoration where you have a functional bed that is self-protecting."

Cownose rays are just another problem that can plague a resource that teeters on the edge. Nonetheless, scientists suggest that grasses in the mid– and high-salinity areas, including eelgrass, can survive. But it means getting them more light—probably even more than called for in the water quality standards—to help compensate for other problems.

That's a tall order for a watershed that gains 100,000 people every year, and loses 100 acres of forest every day. "You've got more people in the watershed," Orth said. "So efforts to try to improve water quality in general is offset by people moving in." Indeed, even in low-salinity areas, the rate of water quality improvements is slowing, and in some cases reversing.

Yet just as the Susquehanna Flats have rebounded in low-salinity areas, there are examples of similar recoveries in saltier areas. In the 1930s—also a warm decade—a wasting disease caused a widespread loss of eelgrass in the Bay and all along the Atlantic Coast. But the grass has been able to come back, at least in part, because water quality was good.

More recently, a grass bed that Orth and colleagues started planting from seeds along Virginia's Atlantic Coast in 1998 has exploded in growth—much like the grass beds in the Susquehanna Flats. The bed now covers hundreds of acres with a dense eelgrass meadow—a stark contrast to any attempt to plant eelgrass in the Bay.

"That's what keeps people hopeful," Moore said. "But there are so many insults combining that it is hard to say, particularly for eelgrass."

Guide to Bay's Underwater Grasses Available

Maryland Sea Grant has produced a new, 72-page guide, "Underwater Grasses in Chesapeake Bay and Mid-Atlantic Coastal Waters" to help citizen volunteers, students and others interested in learning about the critical plants.

The book is 8.5 inches wide and 5 inches tall and is printed on water-resistant paper. It features 138 color photographs, 55 line drawings and descriptions of 20 of the most common SAV species, along with other aquatic plant species people may encounter.

The guide was produced in collaboration with the National Oceanic and Atmospheric Administration's Chesapeake Bay Office, the Alliance for the Chesapeake Bay and the Maryland Department of Natural Resources.

Copies are available for $29.95 from Maryland Sea Grant, plus $2 shipping and handling. For information, visit www.mdsg.umd.edu/store.